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(54) Title: CAPACITIVELY LOADED ANTENNA AND AN ANTENNA ASSEMBLY

(57) Abstract: The present invention relates to an electrically small capacitively loaded antenna comprising ground plane means including a grounding portion, said grounding portion being connectable to a ground connection, at least one radiating element, having a first end and a second end, including a feeding portion at said first end, said feeding portion being connectable to a signal connection, and a capacitive load being connected to said second end of said radiating element, said radiating element has a meandering shape, said ground plane means is arranged in at least two planes which are interconnected, and said antenna further comprises a matching means arranged between said first end of the radiating element and said ground plane means. The invention also relates to an antenna assembly including a capacitively loaded antenna.

Capacitively loaded antenna and an antenna assembly

Technical field

The present invention relates to a capacitively loaded antenna, and in particular to a capacitively loaded meander antenna, according to the preamble of claim 1. The invention also relates to an antenna assembly.

Prior art

A general method for optimising an electrically small antenna for common applications is maximising the product of bandwidth and radiation efficiency for the antenna. Occasionally this can be done by decreasing the reactance of the antenna without decreasing, and preferably by increasing, the radiation efficiency. Decreasing the reactance of a monopole antenna can be done by minimising the inductive loading or maximising the capacitive loading. An added capacitive load will optimally reduce the necessary inductive loading for an electrically small self resonant monopole, will give no added losses, and will increase the total currents on the monopole. Together this means that capacitive loading will increase the above mentioned product of bandwidth and radiation efficiency. Adding a load, capacitive or inductive, at the top is optimum for radiation efficiency, though other mechanical or matching aspects might exclude such top loading. A self resonant electrically small capacitively loaded antenna will still need a minimum amount of inductive loading.

Attempts to optimise the use of an available electrically small cubic volume for an antenna by introducing a top plate and a small coil, in said antenna, can be a mechanical and economical challenge. attempts have been made to take care of this and allow for easy mass production of a robust antenna.

Summary of the invention

The present invention seeks to provide an antenna that optimise the use of an electrically small cubic volume available for the antenna, in particular with respect to radiation efficiency and bandwidth.

According to an aspect of the invention, there is provided a capacitively loaded antenna as specified in claim 1.

Further aspects of the invention is included in the dependent claims.

The invention is also directed to an antenna assembly including a capacitively loaded antenna.

An advantage with the present invention is that a simple construction is obtained thus reducing manufacturing costs.

Another advantage of the present invention is that the antenna may be assembled of flat parts, which are easy to produce and store.

Another advantage is that the antenna may be made very robust only by adding one support.

A further advantage is that no lumped electric component needs to be added for matching the capacitively top loaded antenna, which is an expensive process in manufacturing.

Brief description of the drawings

Fig. 1 shows a preferred embodiment of the present invention.

Fig. 2 shows a principal function of the antenna in Fig. 1.

Fig. 3 shows a second preferred embodiment of the present invention.

Fig. 4 shows a principal function of the antenna in Fig. 3.

Fig. 5 shows an antenna assembly including an antenna according to the present invention.

Detailed description of the preferred embodiment

Fig. 1 shows a preferred embodiment of an antenna 10 according to the present invention. The antenna comprises a vertical radiating element 1, having a meandering shape, a top plate 2, referred to as a capacitive load, and a ground plane means 3-5. The ground plane comprises a first ground member 3 arranged in a first plane and a second and a third ground member 4, 5 arranged in a second plane.

The first ground member has an essentially E-shape and is provided with a grounding point 11 preferably symmetrically arranged. A central portion 12 of the E-shape is connected to a first end 13 of the vertical radiating element 1 via a matching means 6. The first ground member further provides two essentially identical mirror-inverted branches each having a distal point 14, 15.

The first ground member 3 is connected to said second 4 ground member at said distal point 14 and said third 5 ground member at said distal point 15, respectively. The total length from said grounding point 11 to a free end 16 of said second and third ground member, respectively, via said distal point 14, 15, is set to $\lambda/4$, a quarter of a wavelength at the frequency of operation for the antenna 10.

A feeding point 17 is provided at said first end of the vertical radiating element 1. A second end 18 of said radiating element 1 is connected to said capacitive load 2. The capacitive load 2 has a first side 7 and a second side 8,

where said second side 8 is facing the ground means 3-5 and the first side 7 is facing away from the ground means 3-5. The second end 18 of the vertical radiating element 1 is connected to the first side 7 of the capacitive load 2 to allow for a more robust and less compressed meander pattern.

The vertical radiating element 1 and the capacitive load 2 can preferably be made of a solid metal sheet or a partially coated substrate (e.g. a printed circuit board).

The ground plane means preferably comprises a substrate, such as a printed circuit board, on which said first ground member 3 is arranged on a first side and said second and third ground member 4, 5 are arranged on a second side. The first ground member 3 is connected, at the distal end 14, to the second ground member 4, at an end opposite to said free end 16 through said substrate. The first and third ground members are connected is a similar way. The matching means 6 is preferably a printed part of the printed circuit board.

Fig. 2 shows a principal function of the antenna 10 in Fig. 1. A coaxial cable 20 is shown in the figure to indicate how to connect a radio communication apparatus (not shown) to the antenna 10. A signal connector 21 is connected to the feeding point 17 and a ground connector 22 is connected to the grounding point 11. The matching means 6 is illustrated by an inductor between said feeding point 17 and said grounding point 11. The meandering patterned vertical radiating element 1 is illustrated by a meandering line between the feeding point 17 and the capacitive load 2, which is illustrated by a strait line. The ground plane means comprises the first ground member 3, illustrated by a line, and the second and third ground member 4, 5 are illustrated by separate lines.

The first ground member 3 may be arranged on top of the second 4 and the third 5 ground members as shown in figure 1, but it is also possible to arrange the second and third ground members on top of the first ground member 3.

The ground members 3-5 and the capacitive load are preferable arranged in parallel. The total height of the antenna 10 is approximately $\lambda/16$, a sixteenths of the wavelength at the frequency of operation for the antenna.

Fig. 3 shows an second embodiment of an antenna 30. The antenna comprises the same elements as the antenna described in connection with Fig. 1, but the ground plane means has an alternative shaping. The same elements are denoted with the same reference numerals as in Fig. 2. The ground plane means comprises a first member 30 having an open circular shape, where the matching means 6 is connected to a connection at a first end 31 of the first ground member 30 and a second end 32 of the first ground member 30 is provided with a connection 33 to a second ground member 40. The second ground member is a flat surface having substantially the same outer dimensions as the first ground member 30. The connection 33 from the first to the second ground member is located essentially at the centre of the second ground member 40. The grounding point 11 and the feeding point 17 are located at the same place as in Fig. 1.

Fig. 4 shows the principal function of the antenna in Fig. 3. The alternative shape of the ground means is illustrated by a meandering line from the grounding portion 11, corresponding to the first ground member 30, down to a centre portion of a straight line, corresponding to the second ground member 40.

Fig. 5 shows an antenna assembly 50, especially adapted for mounting on a vehicle body, e.g. on the roof of a car. The

antenna 10,.which include the radiation element 1, the top load 2 and the ground plane means 3-5, is mounted on a base 51. A GPS antenna 52 is also provided and mounted on the base 51. In the centre portion of the base 51 is a hole 53 arranged for feeding through cables. An coaxial antenna cable 54, comprising a ground connector and a signal connector, is arranged to be connected to the grounding point and the feeding point, respectively, of the antenna 10. The assembly 50 is covered and protective by a housing 55.

A dielectric support 56 is mounted on the base 51 and is attached at its upper end to the top load 2. Hereby the top load 2 will be steadily fixed and will also serve to support the radiating element 1. Such a support or similar could advantageously also be used in the previous embodiments.

Claims

1. A capacitively loaded antenna comprising:

- ground plane means including a grounding portion, said grounding portion being connectable to a ground connection,

- at least one radiating element, having a first end and a second end, including a feeding portion at said first end, said feeding portion being connectable to a signal connection, and

- a capacitive load being connected to said second end of said radiating element

characterised in that

- said radiating element has a meandering shape,

- said ground plane means is arranged in at least two planes which are interconnected, and

- said antenna further comprises a matching means arranged between said first end of the radiating element and said ground plane means.

2. The antenna according to claim 1, wherein said capacitive load has a first surface and a second surface, where the second end of said radiating element is connected to said first surface of the capacitive load, and said second surface of said capacitive load face said ground plane means.

3. The antenna according to claim 1, wherein said capacitive load has a first surface and a second surface, where the second end of said radiating element is connected to said second surface of the capacitive load, and said second surface of said capacitive load face said ground plane means.

4. The antenna according to any of claims 1-3, wherein said at least two interconnected ground planes are arranged on opposite surfaces of a substrate.

5. The antenna according to any of claims 1-4, wherein said capacitive load is a metal member.

6. The antenna according to any of claims 1-5, wherein said radiating element is a metal member.

7. The antenna according to claim 5 or 6, wherein said metal member is arranged on a substrate.

8. The antenna according to any of claims 1-7, wherein said grounding portion is arranged on a first ground member arranged in a first plane, said first ground member having an E-shape, where said grounding portion is essentially centred thereby creating two essentially identical mirror-inverted branches and one centre portion where said matching means is connected.

9. The antenna according to claim 8, wherein said first ground member is interconnected with a second and third ground member arranged in a second plane at a distal point of each of said branches, respectively, each second and third ground member having a free end.

10. The antenna according to any of claims 8 or 9, wherein said first plane is arranged between said second plane and said capacitive load, essentially in parallel.

11. The antenna according to any of claims 8 or 9, wherein said second plane is arranged between said first plane and said capacitive load, essentially in parallel.

12. The antenna according to any of claims 8-11, wherein the total length from the grounding portion to each free end is a quarter of a wavelength.

13. The antenna according to any of the proceeding claims, wherein said capacitive load is supported by a support, and said radiating element is supported by the capacitive load.

14. An antenna assembly, **characterised in** that said antenna assembly comprises a capacitive loaded antenna according to any of claims 1-13, said antenna assembly being arranged to be mounted on a vehicle.

15. The antenna assembly according to claim 14, wherein said antenna assembly further comprises a GPS antenna.

Fig. 1

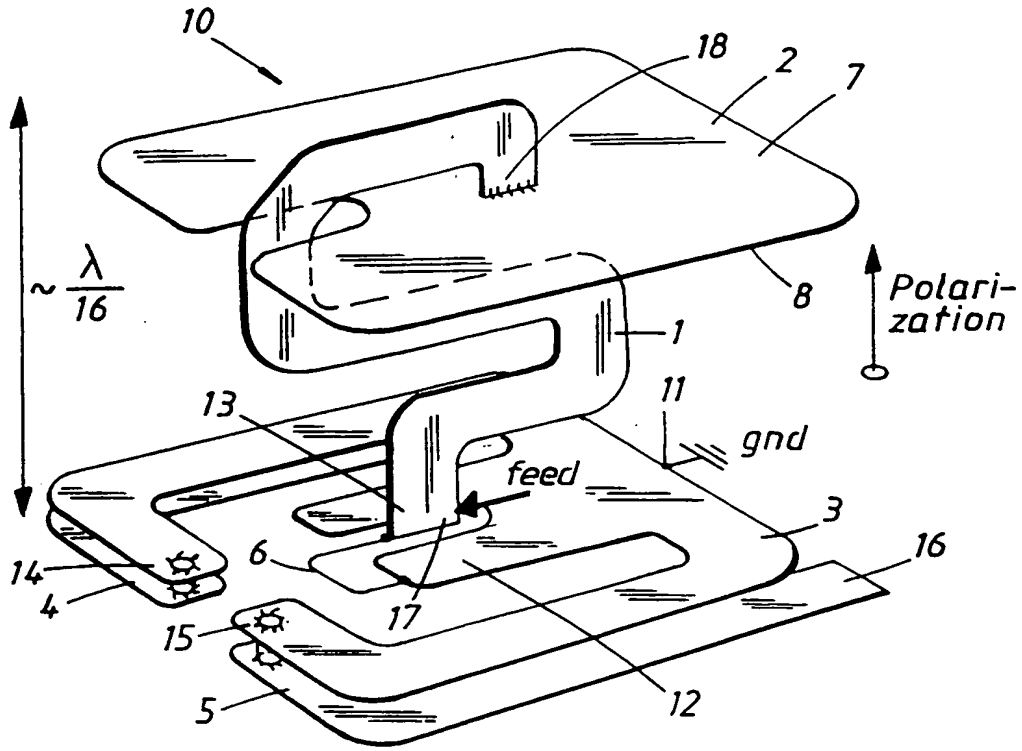


Fig. 2

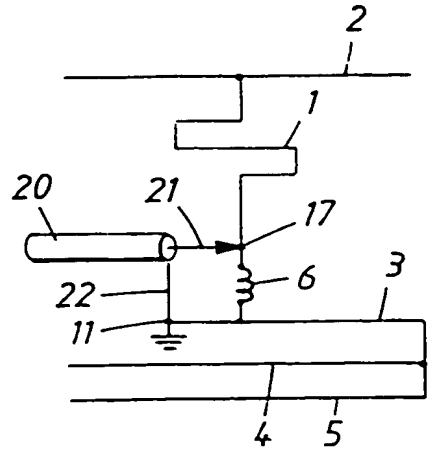


Fig. 3

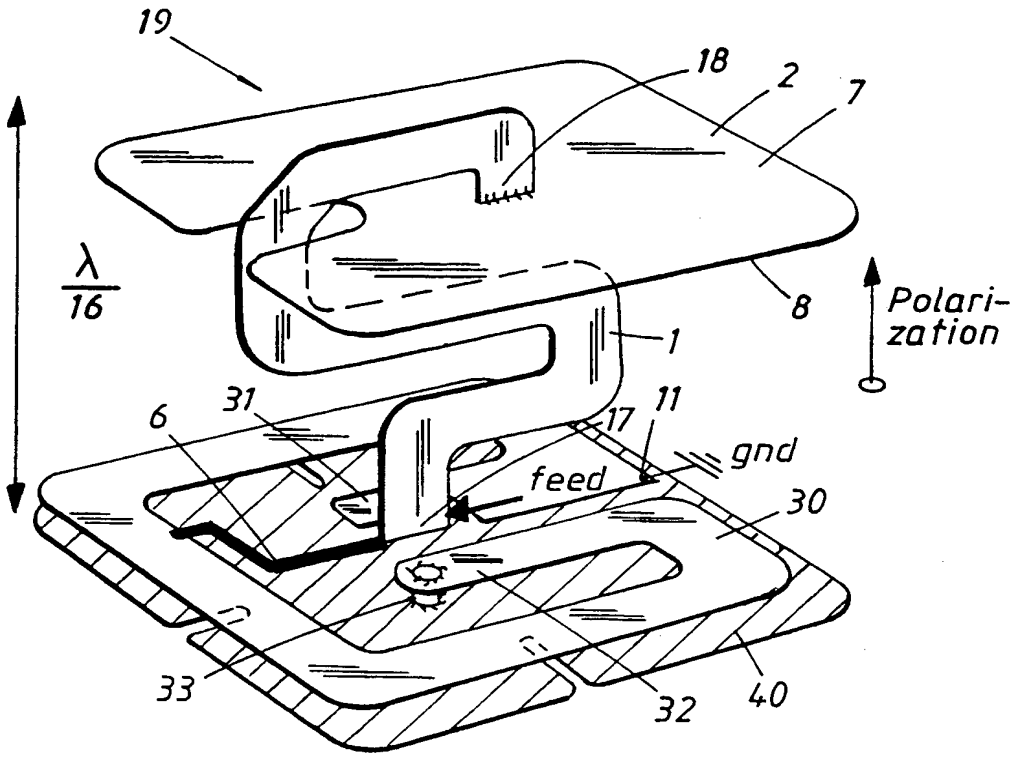


Fig. 4

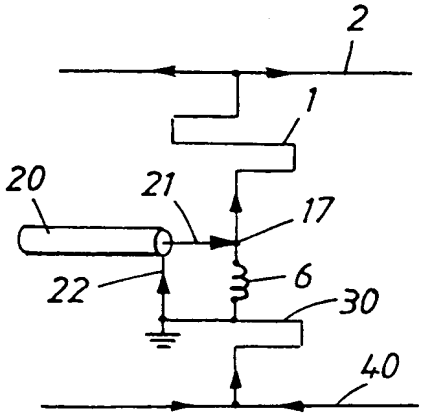
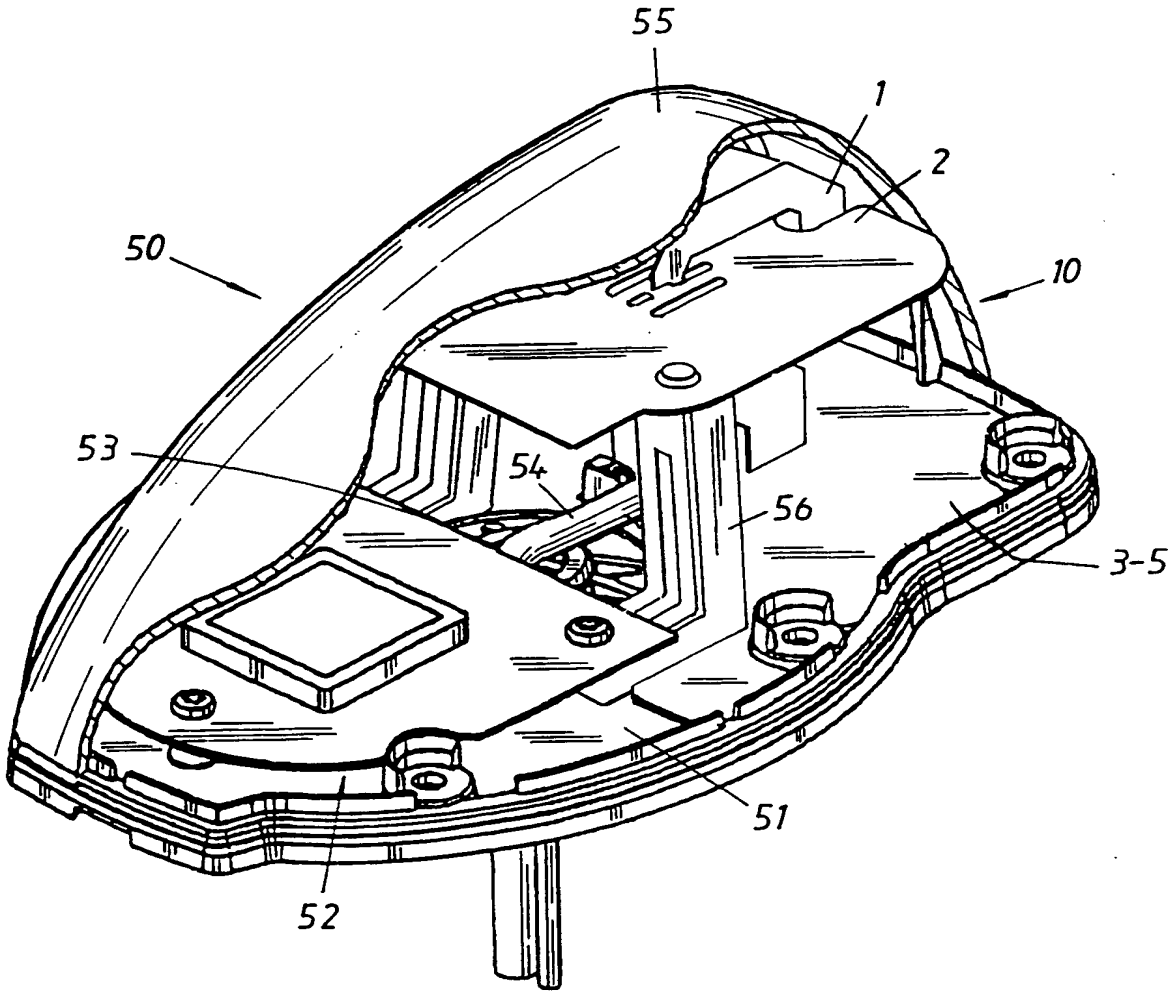


Fig. 5



INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE 00/02333

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: H01Q 1/36
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC7: H01Q

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5278572 A (HARADA, T. ET AL.), 11 January 1994 (11.01.94), the whole document ---	1-13
A	WO 8502719 A1 (MOTOROLA, INC.), 20 June 1985 (20.06.85), the whole document ---	1-13
A	GB 2258952 A (GEC-MARCONI LIMITED), 24 February 1993 (24.02.93), figure 1 --- --------	14-15

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:
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Date of the actual completion of the international search	Date of mailing of the international search report
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Name and mailing address of the ISA/ Swedish Patent Office Box 5055, S-102 42 STOCKHOLM Facsimile No. +46 8 666 02 86	Authorized officer Rune Bengtsson /OGU Telephone No. +46 8 782 25 00

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Information on patent family members

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International application No.
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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
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